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ABSTRACT

This paper describes teacher usage of the microcomputer programs Test Analysis Package (TAP) and Student Problem Package (SPP) to analyze students' test item responses. These methods of organizing, analyzing, and reporting test results have proven useful to classroom teachers. The TAP consists of four integrated microcomputer programs to edit, score, summarize, and analyze student test data at either the item or objective level. The SPP is a program for analyzing student responses on tests based on the Student-Problem Curve Theory developed by T. Sato. Standard reports include student summaries, item summaries, and test summaries. Information available for item analysis includes item ranking in order of difficulty, frequency distributions by quintiles, point-biserial correlations between response options and total test score, and modified caution indices for items (a measure of the irregularity of the responses to the items). The reports also include information useful for analysis of student achievement, including individual student percent correct data, student ranking within the classroom, and objective mastery data. Much of this information is organized into a Student-Problem Chart--a useful, easy to use summary chart of student responses. Illustrations and examples of these reports and their use by classroom teachers are appended. (TJH)

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PRACTICAL APPLICATIONS OF STUDENT RESPONSE ANALYSIS

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Abstract

The paper describes teacher usage of the microcomputer programs Test Analysis Package (TAP) and Student Problem Package (SPP) to analyze students' test item responses. Standard reports include student summaries, item summaries, and test summaries. Information available for item analysis includes item ranking in order of difficulty, frequency distributions by quintiles, point-biserial correlations between response options and total test score, and modified caution indices for items (a measure of the irregularity of the responses to the items). The reports also include information useful for analysis of student achievement such as individual student percent correct, student ranking within the classroom, objective mastery, and modified caution indices for students (an index of unusual response patterns). Much of this information is organized into a Student-Problem Chart, a useful and easy to use summary chart of the student responses. Illustrations and examples of these reports and their use by classroom teachers will be provided.

Mathematicians, computer scientists, and educators are showing considerable interest in the study of item response patterns. Diagnosis of response patterns should be an important part of teaching. The analysis of response patterns is motivated by at least two factors. First, the belief that additional instructional information is contained in the analysis of the errors students make in responding to test items. Secondly, the analysis of response patterns can be useful in test item analysis, where items are examined to see if they are functioning properly to aid in building future tests.

This paper will present methods of organizing, analyzing, and reporting test results that have proven useful to the classroom teachers. Teachers spend a large portion of class time on testing. Dorr-Bremme and Herman (1986) surveyed tenth grade teachers and found that 12% of class time is used for testing. For each hour a student spent taking tests, these teachers reported spending two or more hours in test preparation, scoring, and recording . All in all, testing is a time-consuming operation.

It is only logical that the results of all this testing should be used to the maximum benefit of both students and teachers. But too often the only information a teacher receives is the final score. Typically, even on teacher-made tests, due to the time and effort necessary to get diagnostic material from a test, a total correct score is the only information used. The Student-Problem Package (Harnisch & Romy, 1985) and the Test Analysis Package (Harnisch, Horwitz & Wang, 1984) are two microcomputer programs which analyze test data very efficiently and provide much additional information for teacher use.

Test Analysis Package

The Test Analysis Package (TAP) consists of four integrated microcomputer programs to edit, score, summarize and analyze student test data at either the item or objective level. TAP includes a report generator which summarizes the descriptive statistics for students, items, and the test, producing a frequency distribution of test scores, and optional graphical displays on test quality and student performance. TAP also allows the user to select a subset of the total test items for inclusion in the item analyses, thus helping the user evaluate the best possible test which may be created using those items.

TAP requires data files to consist of one vector (line) of information per student (see Appendix 1A). The first columns consist of the student ID information (which can include school and classroom codes), followed by the actual item responses. TAP also requires a data file consisting of the answer key unless the responses have already been scored as 0/1 (see Appendix 1A). TAP will allow the typing in and storing of an answer key if this has not already been done.

TAP output includes a student summary, item summary, test summary and frequency distribution of test scores (see Appendix 2). There are several optional reports. One provides a listing of the student IDs, scores, and percent corrects. Another lists the student IDs and the scored item responses (0/1) for all items (see Appendix 1B). It is also possible to request a report of the point-biserial correlations between the response options (distractors) and the total test scores (see Appendix 3).

Another set of optional reports analyzes the student data by quintiles. Here the students are divided into five approximately equal groups: the one-

fifth scoring the lowest on the total test score, up to the one-fifth scoring the highest. The user then has the option of choosing several reports on these five groups. TAP will report the score ranges within each group and the percent of correct responses to each item by quintile (see Appendix 4). The user can choose to have these percent corrects by quintile reported in graphical form (see Appendix 5). There is also an option that reports the frequency of responses to each item response option by quintile (see Appendix 6).

Should the user wish to perform an objective analysis of the student data, TAP will accept input of up to 10 objectives (with labels), which items map into each objective, and the number of items needed to master each objective. The TAP objective analysis report includes a listing of student IDs with the percent of objectives mastered and an indication of which objectives were mastered (see Appendix 7). This report also includes descriptive statistics on each objective, means, standard deviations, standard errors, number of students mastering, average item difficulty, reliability, etc., (see Appendix 7b), and a graph of the percentage of students mastering each objective. Finally the objective analysis includes the frequency distribution of objective mastery by quintiles, and the percent of students mastering each objective by quintiles.

Student-Problem Package (SPP)

The Student-Problem Package (SPP) is a program for analyzing student responses on tests based on Student-Problem Curve Theory developed by Takahiro Sato at NEC Corporation, Tokyo (Sato, 1980; Sato & Kurata, 1977). S-P curve theory allows the recovery of additional information from the pattern of responses by students to items. Like TAP, SPP uses a data file consisting of

one line per student containing the student ID and item responses. SPP also requires a data file consisting of the answer key, unless the responses have already been scored (0/1). (See Appendix 1A for examples).

S-P Chart

An S-P Chart consists of an ordering of the student item responses in the form of a table (see Appendix 8). The problems are ordered from easiest (most number of students answering correctly) to hardest, and the students are ordered from highest total score to lowest total score. Each row of this matrix contains the responses of a student. A "+" indicates a correct response while a number represents the distractor chosen. [The "S" and "P" notations are discussed in the next section.] The columns of the matrix correspond to items on the test. The sum of each row represents the raw score (total score) for each student. For each student the S-P Chart lists the raw score (total items correct), the percent of items answered correctly, the Modified Caution Index (MCI) and Modified Caution Sign (MCS). [The MCI and MCS will be discussed later in this paper.]

In addition to the S-P Chart, the program reports item statistics: number of students getting the item correct, the percent correct, MCIs and MCSs for items, and the average MCI (see Appendix 9). Reported test statistics include the mean total score, test reliability (Cronbach's Alpha), and the disparity coefficient (an index of the classroom/test fit). A short student summary includes the average raw test score (and its standard deviation), and the average student MCI (see Appendix 9).

Appendix 10 illustrates further output from SPP in chart form. The teacher can quickly see how many students were classified as high and low (total test score), and with high and low MCI's (chart 1). Also shown is the

set of cut-off values chosen. The number of items classified as hard and easy, and with high and low MCI's is shown in Chart 2.

Through the optional Categorized S-P Chart, the SPP program allows for analysis by objective (see Appendix 11). The items, grouped by objective, are ranked left to right from easiest to hardest. This ranking is done using the average percent of the class that got items correct in that objective. Then the items within each group are ordered from easiest to hardest. Otherwise the format of the Categorized S-P chart is similar to that of the regular chart.

S-P Curves

There are two lines that can be drawn on the S-P Chart. The S-curve provides a visual display of the proficiency level of the students in the classroom (see Appendix 8). Each S is placed at the position in each row representing the number of items that student got correct. A vertical S-curve represents a homogeneous classroom (one in which most of the students are performing very similarly), where a diagonal S-curve is evidence of a heterogeneous classroom (a wide range of performance). An S-curve shifted to the right shows a high proficiency level in the classroom.

A P is placed in each column at that position corresponding to the number of students correctly answering the item. In an ideal classroom with an ideal test (where everything tested is taught and learned) the S and P-curves would coincide. It is quite common to have the S and P-curves diverge a little from each other, due to individual differences commonly observed in the classroom. If the test is measuring information not covered in the classroom, the divergence will be increased. A large divergence (or disparity) between the S and P-curves signals a possible mismatch of test

objectives and instructional objectives in the classroom. A disparity index is given in the SPP analyses for each S-P Chart. A disparity greater than .6 should be interpreted as a danger signal (Harnisch, 1983).

Modified Caution Index

The degree to which a response pattern might be considered unusual is represented by a value called the Modified Caution Index (MCI). This index is based on Student-Problem curve theory. The MCI for a student is computed from a formula that includes such values as the student's total score and the number of persons that got each item correct (see Harnisch and Linn, 1981, for more details). The MCI for an item is computed in a similar manner. The MCI ranges from 0 to 1 where a value of 1 represents a response pattern totally inconsistent with the expected pattern based on the classroom performance, while a value of 0 represents a pattern consistent with the expected performance. As a result, the larger the MCI values, the greater the indication that this response pattern represents a major departure from an expected pattern. Typically, an MCI greater than .30 means the student's total score should be considered with caution.

The Modified Caution Sign (MCS) is an aid for quickly picking out those students with unusual response patterns. An 'A' signifies an adequate total score (this cut-off is determined by the teacher) and a consistent response pattern (MCI < .30). A 'B' signifies an adequate total score but an inconsistent pattern (MCI > .30). A 'C' indicates a low total score but a consistent pattern, while a 'D' indicates a low total score and an inconsistent pattern. This way a teacher can quickly read down the MCS column and pick out those students with B's and D's. These students' total scores

should be considered with caution, and their responses should be examined more carefully.

Modified Caution Signs for items are assigned in a similar manner. An item that is relatively hard and has a high MCI will have an MCS of 'X'. A hard item with a low MCI will be assigned a 'W', an easy item with a low MCI will be assigned a'Y' and an easy item with a high MCI will be assigned a 'Z'.

The Data Source

The data used in the reports found in these appendices came from a single classroom of 20 students in a suburban Chicago school district. The test was a Basic Algebra semester exam. From this test, twenty-two items have been chosen to be analyzed, with those items grouped into four objectives or content domains.

Individual Student Analysis

TAP and SPP reports contain the basic test information needed by every teacher, including a list of student IDs with corresponding total scores and percent corrects. If the teacher desires to know exactly which items were missed by each student, an optional report will list a 0/1 matrix of students and responses (Appendix 1B). More detailed information of this sort can be found on the S-P Chart (Appendix 8) where SPP provides the actual distractor chosen. The S-P Chart also ranks the students for easy identification of those students with lowest scores.

From the S-P Charts, response patterns of students can be examined to determine the accuracy of the individual's total score. Response patterns for students are unusual to the extent that students answer some easy items incorrectly while answering some difficult items correctly. A wide variety of factors may lead to an unusual response pattern. These include sporadic study

habits, absence at the time a topic was covered in class, carelessness, a common misunderstanding, test anxiety, not feeling well, poor test taking skills, a short attention span, or an underdeveloped cognitive structure. Also, hidden strengths due to experiences outside the classroom or unusually high interest in a specific topic can contribute to unusual patterns of right and wrong answers.

On the sample S-P Chart in Appendix 8 it is possible to pick out the students with troublesome response patterns by looking for MCIs greater than .30 (or an MCS of B or D). Only one student, the last, has been identified in this manner. The MCI of .43 indicates some concern about the representativeness of the low test score of 22.7%. This student's test should be considered for further understanding of the test score. The fact that the five correct items are not all ones that were easy for the class as a whole was the reason (but not the explanation) of the high MCI. Two other students did not make the cut-off of .30, but have high MCIs: the first, with .29, and the next to last, with .26. In general, any item missed above the S-curve is unusual since it is relatively easy for the class (see student one and item 14). On examination it may appear to be as simple an explanation as carelessness. But, too, these items might represent missed class days, and/or concepts unlearned.

When items are analyzed by objectives (or content domain), teachers may obtain information on a student's understanding of that concept. Specific lists of which objectives have been mastered by individual students are given by TAP (Appendix 7). SPP can print an S-P Chart organized by objective (Appendix 11), which gives more detailed information. From a Categorized S-P Chart the teacher can see which objectives are troublesome to which students,

and which items within each objective are missed. In the example chart in Appendix 11, the high MCI for the last student is clearly explained. Almost all of the items he got correct were factoring problems. Here the teacher has uncovered an unexpected strength. It is possible the student had extra tutoring in this area, or just understood it very well. The Categorized S-P Chart can pinpoint problem areas for concentrated work, and find students with strengths who can be paired with those who need help.

Item Analysis

It is important to a teacher who wishes to build a bank of test questions to determine which items are appropriate for using again. Items with incorrect answer keys, or ones that might not have been covered completely in the classroom may also be identified. SPP reports the items in order of difficulty (Appendix 9), including the percentage of students getting the item correct. Notice that item 3 was very easy for this class (all got it correct), while item 10 was very difficult (only one student got it correct). The listing of item MCIs and MCSs (Appendix 9) gives an indication of unusual patterns of responses. Response patterns for items are unusual to the extent that items are answered incorrectly by high scoring students (i.e., high total score) and correctly by low scoring students. This situation suggests random responses by students (guessing), or something unusual about the content of an item, e.g., its wording or the nature of what is being asked. The MCI of an item is an indicator of item fit to the classroom of students. If the item MCI is greater than .30 (that is, indicated with 'X' or 'Z' for its MCS), the item should be reviewed before it is used again. Note that three items have been identified in this manner: 14, 16, and 7.

The study of which students tended to get an item correct is also useful in item analysis. The point-biserial correlation between an item (0/1) and the total test score can be an indication of this type. A high point-biserial means that the students with high scores tend to get the item correct, while students with low scores tend to get it wrong. The TAP report of point-biserials can be seen in Appendix 3. Note that item 1 has a high value for the fourth response option (the correct answer, indicated with an asterisk). This implies that the item is behaving properly in this classroom. Note that the point-biserial for item 16 is rather low, and that two of the distractors have positive correlations too. More evidence that this item should be studied. Similar information can be found by looking at the percent of correct responses by quintiles (Appendix 4). It would be expected that the 5th quintile should get the highest percent correct, gradually decreasing down to the 1st quintile. Notice that item 7 does not follow this pattern at all. Although 50% of the 5th quintile got item 7 correct, it drops to zero for the 4th and 3rd, then back up to 25% and 33% for the 2nd and 1st respectfully. This pattern can be seen graphically in Appendix 5. This item is performing quite curiously in this classroom.

In performing an item analysis, the distractors (the incorrect options) should be carefully examined. A distractor should not attract very good students (a sign of a tricky question or incorrect answer key). A good distractor should tell the teacher what misunderstanding has caused the student to answer the item incorrectly. By looking at the responses chosen by quintiles (Appendix 6), a teacher can determine which distractors are favored by each group. Note that for item 7, the higher quintiles are split between option 1 and 5 (4 is the correct answer), but the lower groups tend to choose

option 5. S-P Charts (Appendix 8) can give similar information about distractors. By looking down the column of an item one can see if the higher scoring students (those at the top of the chart) are choosing different distractors than those nearer the bottom. Item 6 is a good example for this classroom. Note that the higher scoring students are choosing 3, while the low scorers are tending to choose 4. This type of analysis can aid in the understanding of right/wrong answers as well as decisions on whether an item should be included in a test bank.

Classroom Analysis

TAP and SPP reports present much of the basic classroom information a teacher may need. To get an idea of general test performance, the mean test score and the distribution of test scores can be useful, as well as the reliability (Appendix 2). The disparity coefficient is an index of how well the test fits this classroom of students (Appendix 9). For this classroom, the disparity coefficient is .44, well below the caution point of .60, signifying a relatively good test for this class. More than likely all the information tested was presented in some form to these students.

By grouping items into objectives or content domains, the information from SPP and TAP can be extremely useful in guiding instruction, since they contains important summary information for use by the classroom teacher. One can identify the content areas on which the classroom as a whole might need further instruction and practice. By grouping items in this manner, the information more closely matches the way teachers presents topics in the classroom. TAP reports the percent of students mastering each objective, as well as the reliability of the subtest created by the objective (Appendix 7b). In this sample report, 95% of the class mastered objective 3 (polynomials),

with its average item difficulty of .84 (on the average, 84% of the students got each item in this objective correct). Using a Categorized S-P Chart the results of a test can be utilized quickly. In fact, many teachers find the Categorized S-P Charts quite useful (Switzer, 1987). The teacher can readily see which content areas are understood by much of the class (those listed on the left side of the chart) and therefore can be considered their strengths. The last few topics may need extra review and concentration. Since items are ordered easiest to hardest within each category, this helps the teacher spot those items within each objective that are giving the classroom the most trouble.

Summary

Analysis of item responses using TAP and SPP reports provide a method of systematically looking at student achievement patterns on common areas of content. Detailed output provides a teacher with concise reports identifying instructional areas in need of review, students with unusual response pattern, and items that need further study. This paper has attempted to demonstrate the potential usefulness of such reports for classroom teachers.

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APPENDIX 1A

TAP and SPP Data and Key Files

Data File:

```
92183541134243313535254412 11
92053041134253343533244412 11
92001031134211433535552312 11
92154551135353334532553512 13
92055045134351322533553412 21
92029545134313423535553512 11
92109542124451434334453512 11
92097524135453134513424412 11
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Answer key file:

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411342433135332444121 1
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APPENDIX 1B

TAP: Scored Responses to Items

STUDENT RESPONSES TO TEST ITEMS

STUDENT ID NO.	ITEM NO. 00000000011111111112 22 12345678901234567890 12
921835	11111111111110101111 11
920530	11111101101111111111 11
920010	01111100001110000011 11
921545	01110001100110000011 10
920550	10111000100111000111 01
920295	10111001001110000011 11
921095	10101000000010000011 11
920975	00110001000101001111 11

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1 - CORRECT RESPONSE
0 - INCORRECT RESPONSE

APPENDIX 2

TAP: Descriptive Statistics

STUDENT SUMMARY

NUMBER OF TEST ITEMS	-	22
AVG. TEST SCORE	-	12.25
STD. DEV. OF TEST SCORE	-	3.92
STD. ERROR OF MEAN	-	0.88
SKEWNESS	-	0.57
KURTOSIS	-	2.73
NUMBER OF TEST SCORES	-	20

ITEM SUMMARY

AVG. ITEM DIFFICULTY	-	0.56
STD. DEV. OF ITEM DIFFICULTY	-	0.28

TEST SUMMARY

RELIABILITY COEF. (KR-20) - 0.79

Frequency of Total Test Scores

FREQUENCY DISTRIBUTION OF TEST SCORES

RAW SCORE	STANDARDIZED SCORE	FREQ	CUM FREQ	EACH * REPRESENTS 1 PERSON
20	698	2	20	**
19	672	1	18	*
18	647	0	17	
17	621	0	17	
16	596	0	17	
15	570	1	17	*
14	545	2	16	**
13	519	0	14	
12	494	5	14	*****
11	468	2	9	**
10	443	4	7	****
9	417	0	3	
8	392	2	3	**
7	366	0	1	
6	341	0	1	
5	315	1	1	*

APPENDIX 3

TAP: Point Biserial Correlations

POINT-BISERIAL CORRELATIONS BETWEEN
RESPONSE OPTIONS AND TOTAL
TEST SCORE

ITEM #	RESPONSE OPTION 1	2	3	4	5	OMIT
1	-0.41	-0.21	-0.02	0.53*	-0.14	0.00
2	0.64*	-0.19	-0.17	-0.37	-0.03	-0.14
3	0.00*	0.00	0.00	0.00	0.00	0.00
4	-0.44	-0.20	0.43*	0.00	0.00	0.00
5	0.00	-0.11	-0.44	0.38*	-0.13	0.00
6	0.00	0.47*	0.16	-0.62	0.00	0.00
7	0.08	0.00	-0.44	0.26*	-0.09	0.00
8	-0.53	0.00	0.51*	0.17	-0.15	0.00
9	-0.15	0.11	0.34*	-0.38	0.17	0.00
10	0.47*	-0.03	-0.41	0.29	-0.02	0.00
11	-0.17	-0.10	0.41*	-0.19	0.00	-0.02
12	-0.24	-0.44	-0.26	-0.14	0.58*	0.00
13	-0.08	0.00	0.37*	0.00	-0.44	0.00
14	0.00	-0.20	0.25*	-0.26	-0.02	0.00
15	-0.28	0.60*	0.00	-0.47	-0.10	0.00
16	0.11	-0.37	-0.20	0.26*	0.07	0.00
17	0.02	-0.10	-0.19	0.45*	-0.44	0.00
18	-0.08	0.00	-0.33	0.59*	-0.30	0.00
19	0.41*	-0.14	-0.44	0.00	0.00	0.00
20	-0.44	0.44*	0.00	0.00	0.00	0.00
21	0.43*	-0.43	0.00	0.00	0.00	0.00
22	0.32*	0.00	-0.32	0.00	0.00	0.00

* INDICATES CORRECT RESPONSE OPTION

APPENDIX 4

TAP: Analysis by Quintiles

QUINTILE FREQUENCY DISTRIBUTION OF TEST SCORES

QUINTILE	NO. OF SCORES	PROPORTION OF SCORES	SCORE RANGE
1ST	3	0.15	5 - 9
2ND	4	0.20	10 - 10
3RD	2	0.10	11 - 11
4TH	7	0.35	12 - 14
5TH	4	0.20	15 - 20

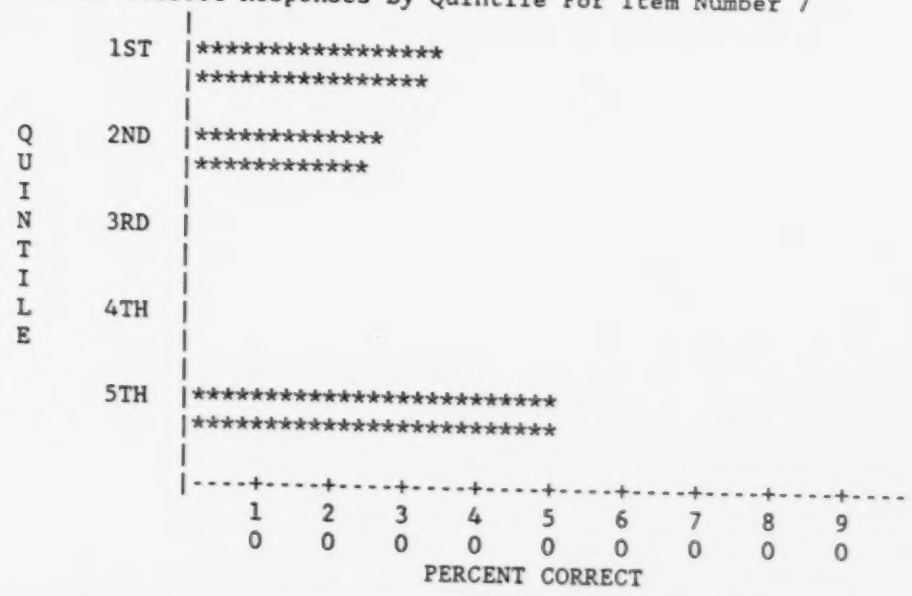
PERCENT OF CORRECT RESPONSES TO TEST ITEMS BY QUINTILES

ITEM #	1ST	2ND	3RD	4TH	5TH
1	33	0	0	43	100
2	0	25	0	14	100
3	100	100	100	100	100
4	33	100	100	86	100
5	67	25	50	71	100
6	0	25	0	43	75
7	33	25	0	0	50
8	0	50	50	71	75
9	33	25	50	43	75
10	0	0	0	0	25
11	33	0	0	29	75
12	0	75	50	100	100
13	67	100	50	100	100
14	33	25	50	57	75
15	0	25	50	43	100
16	0	25	50	14	50
17	33	25	50	14	75
18	0	25	50	43	75
19	67	75	100	100	100
20	67	100	100	100	100
21	33	100	100	86	100
22	67	50	100	100	100

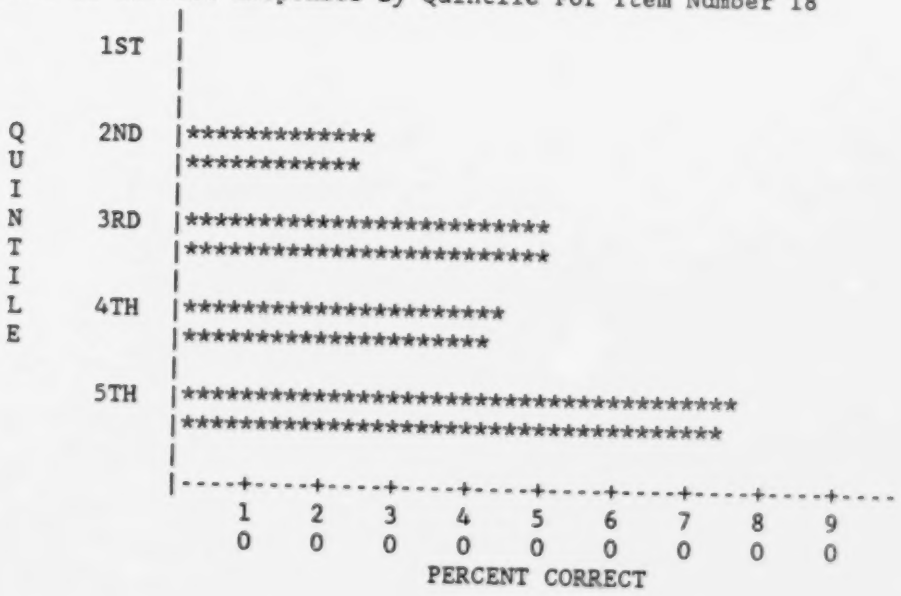
APPENDIX 5

TAP: Graphical Representation of Percent Correct by Quintiles

Percent Of Correct Responses By Quintile For Item Number 7



Percent Of Correct Responses By Quintile For Item Number 18



APPENDIX 6

TAP: Analysis of Responses by Quintiles

*** ITEM 7 ***

FREQUENCY OF RESPONSES BY QUINTILES

RESPONSE OPTION	QUINTILE 1ST	2ND	3RD	4TH	5TH	PROP.OF RESPONSE
1	0	0	1	3	1	0.25
2	0	0	0	0	0	0.00
3	1	0	0	0	0	0.05
4*	1	1	0	0	2	0.20
5	1	3	1	4	1	0.50
OMIT	0	0	0	0	0	0.00

* INDICATES CORRECT RESPONSE

*** ITEM 18 ***

FREQUENCY OF RESPONSES BY QUINTILES

RESPONSE OPTION	QUINTILE 1ST	2ND	3RD	4TH	5TH	PROP.OF RESPONSE
1	0	0	1	0	0	0.05
2	0	0	0	0	0	0.00
3	1	1	0	2	0	0.20
4*	0	1	1	3	3	0.40
5	2	2	0	2	1	0.35
OMIT	0	0	0	0	0	0.00

* INDICATES CORRECT RESPONSE

APPENDIX 7

TAP: Objectives Mastered

STUDENT ID	TOTAL (& OF) SKILLS MASTERED	OBJECTIVE SCORES (* = MASTERY)			
		1	2	3	4
921835	4(100.0)	7*	3*	7*	3*
920530	4(100.0)	7*	2*	7*	4*
920010	1(25.0)	4	0	6*	2
921545	1(25.0)	2	1	6*	1
920550	2(50.0)	2	1	6*	3*
920295	1(25.0)	2	1	7*	2
921095	1(25.0)	1	0	6*	1
920975	2(50.0)	2	2*	5*	2
920685	1(25.0)	0	0	1	4*
920485	1(25.0)	3	1	7*	1
920645	1(25.0)	2	1	6*	1
920825	2(50.0)	3	1	5*	3*
920760	1(25.0)	4	1	5*	0
920600	1(25.0)	3	0	6*	2
921685	2(50.0)	4	2*	6*	2
920230	1(25.0)	3	0	5*	0
920970	3(75.0)	3	2*	6*	3*
921385	1(25.0)	2	0	6*	2
920130	2(50.0)	6*	0	7*	2
920398	4(100.0)	6*	2*	7*	4*

OBJECTIVE LEGEND
1- Equations
2- Inequalities
3- Polynomials
4- Factoring

APPENDIX 7B

TAP: Objective Summaries

OBJECTIVE NUMBER	AVG. OBJ. SCORE	STD. DEV.	STD. ERROR OF MEAN	SKEW-NESS	KUR-TOSIS	# OF STU-DENTS MAS-TERING	& OF STU-DENTS MAS-TERING	AVG. ITEM DIFFI-CULTY	STD. DEV. OF ITEM DIFF.	RELIA-BILITY COEF. (KR-20)
1	3.30	1.92	0.43	0.57	2.36	4	20.0	0.41	0.19	0.62
2	1.00	0.92	0.21	0.39	1.97	6	30.0	0.33	0.26	0.55
3	5.85	1.35	0.30	-2.19	8.56	19	95.0	0.84	0.20	0.70
4	2.10	1.21	0.27	-0.01	2.02	7	35.0	0.52	0.23	0.57

APPENDIX 8

SPP: The S-P Chart

Student Problem (S-P) chart analysis of Basic Algebra
School: Eastside Instructor: D. Smith (=92)
Number of students: 20 Number of problems: 22

Student Number	Test Score (Raw)	Test Score (%)	Modified Caution Ind/Sgn	Problem Number 0 2 1 1 0 2 2 1 0 0 1 0 1 0 1 0 1 0 1 1 0 1 / 3 0 3 9 4 1 2 2 5 8 4 9 5 1 8 6 7 2 1 6 7 0
Answer Key				----------> 1 2 3 1 3 1 1 5 4 3 3 3 2 4 4 2 4 1 3 4 4 1
921835	20	90.9	0.29 A	+ + + + + + + + + + + 5 + + + + + + + + + 5S+ +
				P
920530	20	90.9	0.00 A	+ +S5 4
920398	19	86.4	0.06 A	+ + + + + + + + + + + + + + + + 3 + + +S5 + 4
920130	15	68.2	0.11 A	+ + + + + + + + + 4 + 5 + + 5S+ 3 + 4 + 1 3
				P
921685	14	63.6	0.10 A	+ + + + + + + + 5 + + 2 + 2S+ 3 + 2 4 + 1 4
				P
920970	14	63.6	0.02 A	+ + + + + + + + + + + + 5 2S+ + 1 3 1 1 5 2
				P P
920010	12	54.5	0.11 A	+ + + + + + + + + 1 5 4S5 3 3 + 2 + + 5 1 3
				P P
920550	12	54.5	0.12 A	+ + + + + 2 + + + 1 + +S5 + + 3 3 5 2 5 5 2
				P P
920295	12	54.5	0.05 A	+ + + + + + + + + + 5 4S5 + 5 3 3 5 + 5 1 2
				P P
920485	12	54.5	0.08 A	+ + + + + + + + 2 + 5 4S+ + 5 + 3 5 5 5 3
				P
920825	12	54.5	0.08 A	+ + + + 2 + + + + + + +S+ 3 3 3 2 2 2 5 5 5
				P
920975	11	50.0	0.15 C	+ + 1 + + + + + 5 + +S1 4 2 + 4 + 4 4 2 5 3
920600	11	50.0	0.12 C	+ + + + + + + 1 + 5 5S+ + 2 1 4 1 2 4 + 1 3
				P
921545	10	45.5	0.14 C	+ + + + + + 3 + 5 +S2 + 5 5 5 3 3 + 4 5 5 3
920645	10	45.5	0.19 C	+ + + + + + + 4 5 5S2 4 1 1 + 4 + 2 3 + 2
				P
920760	10	45.5	0.20 C	+ + + 2 + + 3 + + +S5 1 + 2 5 4 3 2 1 + 5 3
921385	10	45.5	0.07 C	+ + + + + + + + 2 1S+ 4 5 2 3 + 2 3 4 3 5 3
				P P P
921095	8	36.4	0.11 C	+ + + + 2 + + 3S+ 1 4 4 4 + 5 4 3 2 4 5 5 3
				P P
920230	8	36.4	0.26 C	+ + + + + 2 3 1S+ 1 5 4 1 2 5 4 + 3 1 5 + 3
				P
920685	5	22.7	0.43 D	+ 1 5 3 1S2 + 2 3 1 + + 4 1 3 4 5 4 + 2 3 4
				P

APPENDIX 9

SPP: Descriptive Statistics

**** PROBLEM STATISTICS ****

Permuted Problem Number	Answer Key	Problem Total	Percent Correct	Modified Caution Ind/Sgn
3	1	20	100.0	0.00 Y
20	2	19	95.0	0.00 Y
13	3	18	90.0	0.11 Y
19	1	18	90.0	0.07 Y
4	3	17	85.0	0.11 Y
21	1	17	85.0	0.11 Y
22	1	17	85.0	0.18 Y
12	5	15	75.0	0.02 Y
5	4	13	65.0	0.21 Y
8	3	11	55.0	0.15 Y
14	3	10	50.0	0.33 X
9	3	9	45.0	0.27 W
15	2	9	45.0	0.09 W
1	4	8	40.0	0.15 W
18	4	8	40.0	0.11 W
6	2	7	35.0	0.21 W
17	4	7	35.0	0.23 W
2	1	6	30.0	0.12 W
11	3	6	30.0	0.27 W
16	4	5	25.0	0.38 X
7	4	4	20.0	0.40 X
10	1	1	5.0	0.00 W

**** STUDENT SUMMARY ****

Average raw score	= 12.25
Standard deviation of raw score	= 3.92
Average percent of items correct	= 55.68
Average modified caution index	= 0.13
Standard deviation of modified caution index	= 0.10

**** PROBLEM SUMMARY ****

Average item difficulty (%)	= 55.68
Standard deviation of item difficulty	= 5.63
Average modified caution index	= 0.16
Standard deviation of modified caution index	= 0.12

**** TEST SUMMARY ****

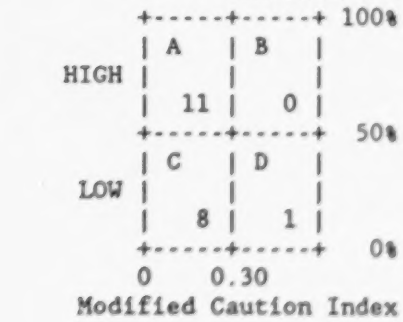
Average overall student performance on test (%)	= 55.68
Reliability coefficient (Cronbach's alpha)	= 0.79
Disparity coefficient	= 0.44

APPENDIX 10

SPP: Charts for Students and Items

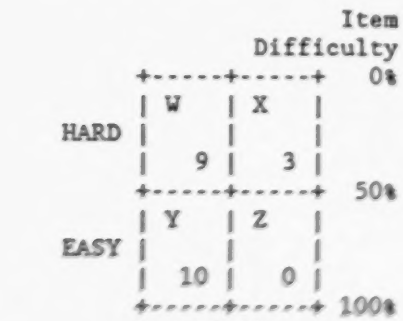
**** CLASSIFICATION AND FREQUENCY ****
**** DISTRIBUTION TABLES ****

(1) Number of students in each cell classified by test performance and modified caution index



Student Cell	Percent Correct	Modified Caution Index
A	> 50%	<= 0.30
B	> 50%	> 0.30
C	<= 50%	<= 0.30
D	<= 50%	> 0.30

(2) Number of items in each cell classified by item difficulty and modified caution index



Item Cell	Percent Correct	Modified Caution Index
W	<= 50%	<= 0.30
X	<= 50%	> 0.30
Y	> 50%	<= 0.30
Z	> 50%	> 0.30

APPENDIX 11

SPP: The S-P Chart of Objectives

Student Problem (S-P) chart analysis of Basic Algebra

School: Eastside
Number of students: 20

Instructor: D. Smith (#92)
Number of problems: 22

Student Number	Test Score (Raw)	(%)	Modified Caution Ind/Sgn	Problem Number 0211020 2101 10101010 011 3039411 2491 25567267 880
Category Name ——————>				Polynom Fctr Equation Ineq
Answer Key ——————>				1231314 1333 54224144 341
921835	20	90.9	0.29 A	+++++++ +5++ ++++++5+ +++
920530	20	90.9	0.00 A	+++++++ ++++ +++++++5 ++4
920398	19	86.4	0.06 A	+++++++ ++++ +++3++5+ ++4
920130	15	68.2	0.11 A	+++++++ ++54 ++++3++1 453
921685	14	63.6	0.10 A	++++++2 ++24 +5+3+2+1 ++4
920970	14	63.6	0.02 A	++++++2 +++1 ++5+1315 ++2
920010	12	54.5	0.11 A	++++++3 +54+ ++5+2+51 133
920550	12	54.5	0.12 A	+++++2+ +++2 ++533555 1+2
920295	12	54.5	0.05 A	+++++++ +54+ ++533551 +52
920485	12	54.5	0.08 A	+++++++ +54 +2++3555 +53
920825	12	54.5	0.08 A	++++2+3 +++2 +++32255 +35
920975	11	50.0	0.15 C	++1+++2 ++14 +544+425 ++3
920600	11	50.0	0.12 C	++++++2 +5+4 1++412+1 513
921545	10	45.5	0.14 C	++++++5 32+4 +5533+55 +53
920645	10	45.5	0.19 C	++++++1 +242 4514+ 3+ 5+2
920760	10	45.5	0.20 C	+++2++2 3511 +++432+5 +53
921385	10	45.5	0.07 C	++++++2 ++44 +25+2335 133
921095	8	36.4	0.11 C	++++2++ +444 3+443255 153
920230	8	36.4	0.26 C	+++++22 3541 1+14+35+ 153
920685	5	22.7	0.43 D	+153121 ++++ 23445423 134

Category Rank	Category Name	Percent Correct
1	Polynomials	83
2	Factoring	52
3	Equations	41
4	Inequalities	33